Saskatchewan
Agriculture

Saskatchewan Wild Rice Research 1983

TABLE OF CONTENTS

Research Requirements of Wild Rice Industry in Saskatchewan - Pablito Orcajada, P. Ag., Department of Agriculture	1
An Ecological Investigation of Factors Affecting the Production of Wild Rice in Northern Saskatchewan - Dr. W. O. Archibold, Geography Department, University of Saskatchewan	4
Analysis of the Habitat Potential of Wild Rice in Northern Saskatchewan - B. J. Weichel and Dr. W. O. Archibold, Geography Department, University of Saskatchewan	35
A New Approach to Wild Rice Harvesting in Northern Saskatchewan - Dr. R. Lal Kushwaha, Agricultural Engineering Department, University of Saskatchewan	44
Economics of Wild Rice Farming Pablito Orcajada, P. Ag., Department of Agriculture	58

RESEARCH REQUIREMENTS

OF

WILD RICE INDUSTRY IN SASKATCHEWAN

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While wild rice is believed to have been introduced in Saskatchewan in the mid - 30's, it was not until 1978 when serious efforts were made to promote and expand the crop.

The former Department of Northern Saskatchewan, through its Economic Development Branch, developed and implemented a program which called for expanded trial seeding and an on-going extension program.

A total of 24 individuals initially particpated in the program in 1978. The same program was carried on in 1979. In 1980, the provincial and federal governments jointly, with the Saskatchewan Indian Agriculture Program (S.I.A.P.), provided a substantial amount ($100,000.00) which resulted in the distribution of an average of 500 pounds of seed to 200 individuals all over northern Saskatchewan.

Since then, the wild rice industry in the province continued expanding in area, increasing in production with more people directly particpating. Production last year was almost 10 times more than when the program was started 10 years ago.

YEAR	NUMBER OF COMMERCIAL PRODUCERS	TOTAL PRODUCTION (POUNDS)
1978	18	60,504
1979	20	160,000
1980	24	321,313
1981	86	513,832
1982	81	520,149
1983	67*	551,610

* The reduction in the number of producers in 1983 was primarily due to extensive total crop failure because of bad weather throughout the growing and harvest season. Production could have been much more were it not for the unfavourable weather conditions.

Indeed, the potential of the industry in the province is extremely good. To date more than 1,400 water bodies have been permitted by more than 600 individuals. There could be many more water bodies that have good potential for wild rice growing that have not been identified yet. In addition, the province also has good potential for paddy wild rice growing.

Because of the highly encouraging potential of wild rice as a viable stable industry, research is expected to play a very major role. Current production, processing and marketing problems need to be immediately addressed to ensure production stability and product competitiveness.

Research efforts have already helped the industry in the province. In fact, the initial study which involved the introduction of the first prototype mechanical harvester in the province was a major factor in the rapid expansion of wild rice in Saskatchewan. The five original prototype units which were introduced in 1979 have been improved/renovated over the years. New harvester designs or improvements on the present designs will continue to be a major subject of research as the commercial viability of wild rice farming will depend largely on harvesting efficiency.

The other research projects that have been or are being undertaken include studies on:

1) Factors affecting the production of wild rice in northern Saskatchewan.

2) An ecological analysis of the habitat potential of wild rice in northern Saskatchewan.

3) A new approach to wild rice harvesting in northern Saskatchewan.

While these studies are being done, there is a growing realization of the other urgent problems that confront the industry today. It is imperative that these problems be addressed rather quickly if we are to keep the developing/expanding momentum to continue. Among such urgent problems are:

1. Highly shattering varieties. It is believed that a good percentage of the crop is lost because of the highly shattering character of the current varieties.

2. Prevalence of mixed varieties in a stand. This is easily seen in the non-uniformity of flowering as well as maturity.

3. Wild rice straw which covers the water surface and which does not decay well after spring, affects germination and plant growth. In extreme cases, where the straw is very thick, the crop is totally lost for the year. There is a need to find out how to effectively remove the straw after harvest or how to hasten decomposition so as not to interfere with germination and early plant growth.

4. Plant density. If the plant density (population) is too thick, the growth is hindered, crop is poor and production is very low. In a situation like this, there is a need to find out what is the most effective and efficient method of thinning.

There are many other areas that need to be looked into systematically. To be able to do all of these, will probably need a strengthened research program in terms of funds and manpower.

In the meantime, we are thankful for the willingness and commitment of scientists from the University of Saskatchewan to be able to get the scientific study going.

AN ECOLOGICAL INVESTIGATION OF FACTORS AFFECTING THE PRODUCTION OF WILD-RICE IN NORTHERN SASKATCHEWAN

O. W. ARCHIBOLD AND B. J. WEICHEL

Distribution of Wild Rice

Recently there has been increasing interest in the commercial expansion of wild rice both in native habitats and under paddy cultivation. Current research, particularly in the United States, has been directed at the problems associated with intensive agricultural production of wild rice under artificial habitats. In Canada there has been a growing awareness of the enormous wild rice habitat that exists in the boreal forest region, and investigations are focussing on the present and potential distribution of natural habitats in the northern regions.

The general range of wild rice may be stated as eastern and central North America; Figure 1 shows the distribution in more detail. Southern wild rice *(Zizania aquatica* var. *aquatica)* occupies rivers in a predominantly near-coastal band from the Gulf of Mexico to Maine, while estuarine wild rice *(Zizania aquatica* var. *brevis)* is restricted to the freshwater tidal zone at the mouth of the St. Lawrence River. Northern *(Zizania palustris* var. *palustris)* and interior

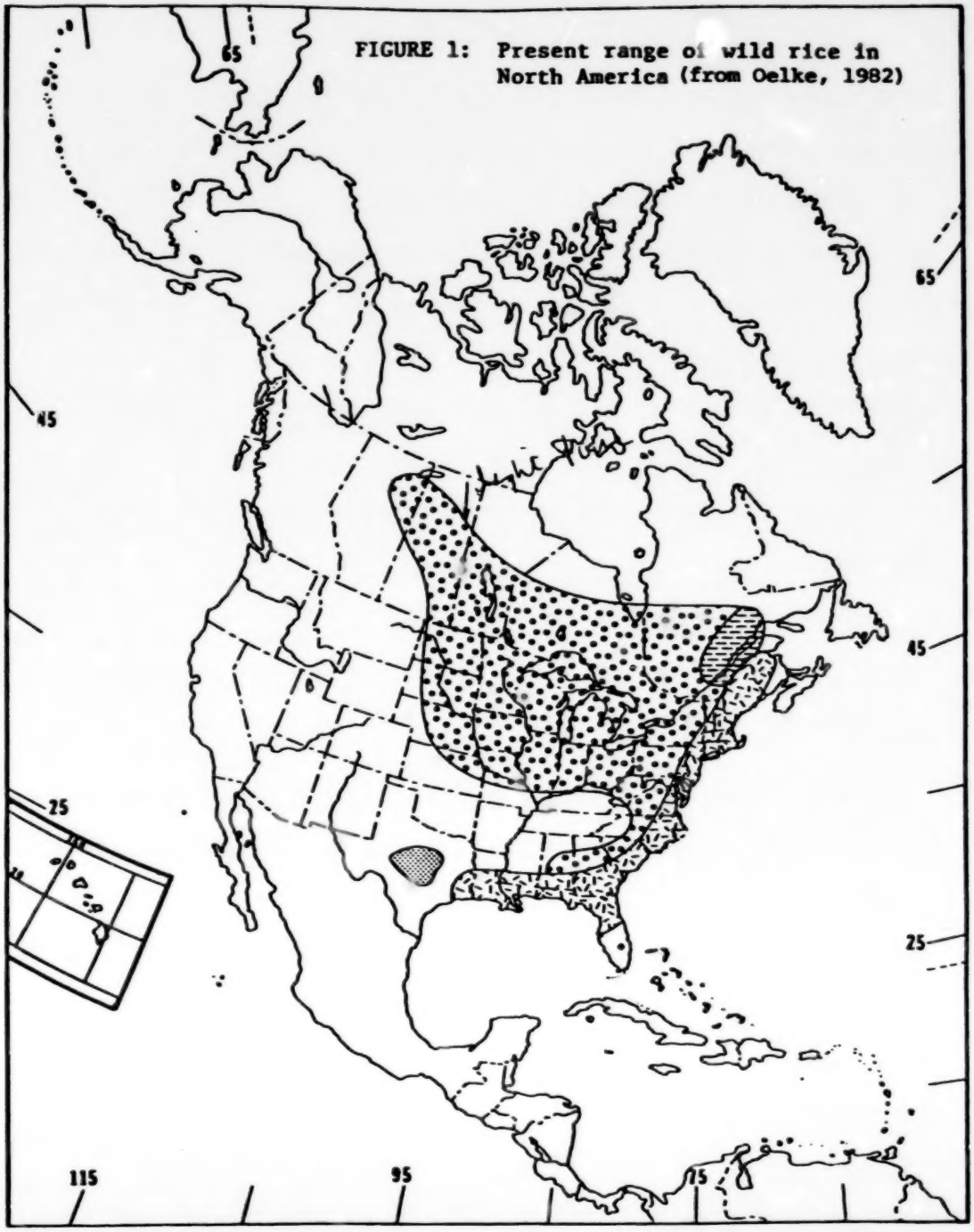


FIGURE 1: Present range of wild rice in North America (from Oelke, 1982)

Zizania palustris varieties *palustris* & *interior*.

Zizania aquatica variety *aquatica*.

Zizania aquatica variety *brevis*.

Zizania texana

wild rice *(Zizania palustris* var. *interior)* are found in the upper Mississippi-Great Lakes region and extending into the southern boreal forest region. These latter varieties are sympatric over a large portion of their species' range, although a latitudinal gradation in dominance is acknowledged. *Zizania palustris* is thus the most widespread species in Canada. This is also the species of commercial value, owing to its large seed size. Few of these stands are considered natural. The majority represent deliberate introductions stemming from interest in the plant as a cereal or forage crop. In Canada the range has been extended into the Maritimes, and northwestward into Alberta and Saskatchewan. Introduction into Saskatchewan is said to have been circa 1935.

Interior wild rice inhabits the upper littoral and eulittoral (seasonally inundated) sections, growing best at depths of 0.5 m or less. Seasonally fluctuating water levels, characterized by an early spring runoff peak and followed by a gradual steady decline through summer often to zero, are considered optimal. Such a regime is typical of lotic waters and accounts for the common name "river rice" for this variety. Northern wild rice on the other hand, appears to be better adapted to the somewhat deeper waters of the upper to middle littoral sections, with an optimal range of 0.5 to 1.0 m. Where it occurs in association with the interior variety it is distinguished from the former by the common

name "lake rice." Although the varieties hydridize to produce intermediate types, careful scrutiny suggests an outer band of predominantly northern wild rice, grading shoreward to an area dominated by the interior variety.

Life Cycle and Phenology

Growth is initiated in spring with the sprouting of previously-dormant seeds imbedded in the sediments. The dormancy is the result of the seed's relatively impermeable coat and the presence of water-soluble growth inhibitors. Germination takes place at between 4 to 6^{o}C, and may be enhanced by temperature fluctuations of the type which would occur during spring turnover in lakes or the commencement of spring flood in streams. Upon germination the seedling may yet be exposed to relatively low 0_2 conditions. The circulation of dissolved 0_2 and the oxygenation of sediments during the spring are considered important in ameliorating this situation.

Growth and development of the plant is well documented. During the initial vegetative growth phase two or three slender leaves are produced; these eventually die off following commencement of the floating leaf stage. One or two ribbon-like leaves lie on the surface, their upper surfaces textured to shed water and remain exposed to the air. At this point the plant has gained access to the increased light, 0_2 and $C0_2$ available above the water. The floating leaves also

enable 0_2 diffusion toward the roots by means of large intrafoliar lacunae.

Within a week or two of the appearance of the floating leaves, production of 3 or 4 long, narrow, aerial leaves occurs and stem elongation takes place. The amount of internodal stem elongation is proportional to the water depth. As a result, plants of a single variety in the same lake may vary substantially in overall height. The interior variety may range from 0.9 to 3.0 m tall, with 1 to 3 cm wide leaves; the northern variety from 0.7 to 1.5 m tall, with leaves 4 to 10 mm wide. The hollow center of the 0.5 to 1.0 cm diameter, lignified stem consists of large, regularly-spaced, membrane-divided lacunae which permit upward and downward diffusion of gases. By this stage the plant is well anchored by a mass of short fibrous roots, with prop roots often arising from higher nodes. A variable number of adventitious stems, or tillers, arise from each plant in the last vegetative stage - the tillering stage.

The reproductive growth phase begins soon after the stems break the water surface, although the stem continues growth until just prior to seed maturity. Wild rice forms a monoecious panicle; the female florets are borne above the male florets and mature earlier, ensuring cross-pollination, with wind as the agent. The propensity of the species to produce intervarietal hybrids, and to exhibit significant

phenotypic heterogeneity is explained in part by this assured cross-pollination.

Maturation occurs progressively downward from the panicle tip over an extended period of 10 to 14 days. A 1 to 2 cm seed is produced, enclosed in a palea and an awned (2 cm) lemma. Average seed length typically increases northward and this undoubtedly reflects the predominance of the northern variety at higher latitudes. Northern wild rice also produces fewer seeds per panicle and exhibits a purplish color in the heads. Ripe seeds in natural stands dislodge (or "shatter") easily from the panicle due to wind or other jostling. Unlike most other aquatic macrophytes whose seeds tend to remain buoyant for dispersal, the heavy wild rice seeds sink rapidly to imbed in the sediments near the parent plant. There they lie dormant for at least one and possibly several winters. Seed viability is reduced quickly by drying. Following seed maturation the parent plant begins to die off and much of the stand's stems may be broken and submerged by the time ice returns.

The developmental rate varies in response to a number of factors, primarily climate and water depth, resulting in annual variations in germination, growth rate, flowering and maturation dates. Monitoring in Minnesota wild rice paddies found that between 85 and 130 days are required to complete the life cycle; 110 to 120 days are considered a

general average. Figure 2 shows a typical phenological outline.

The Importance of Selected Habitat Factors in the Growth of Wild Rice in the La Ronge Area

La Ronge (55°N, 105°W) is situated near the edge of the Canadian Shield in a heavily glaciated area. Numerous lakes, muskegs and rivers are found within this part of the boreal forest and many of the open water bodies have been seeded to wild rice over the past 40 - 50 years. In this study 5 sites were established in the area at which selected physical and chemical parameters of the water, substrate and wild rice were measured over the 1982 growing period. The locations of these sample sites are given in Figure 3.

Methods

The field programme commenced in mid-May and continued till late August, each site being visited at three week intervals during this period. Stage poles were set up at each site to record water level fluctuations. Water conductivity at a depth of approximately 1 meter was measured at all sites using a YSI conductivity meter, the same instrument being read simultaneously for temperature. Additional on-site measurements were made for dissolved oxygen (YSI oxygen meter), dissolved carbon dioxide (colorimetrically using Hach reagents), and pH (glass electrode). All measurements were carried out in triplicate.

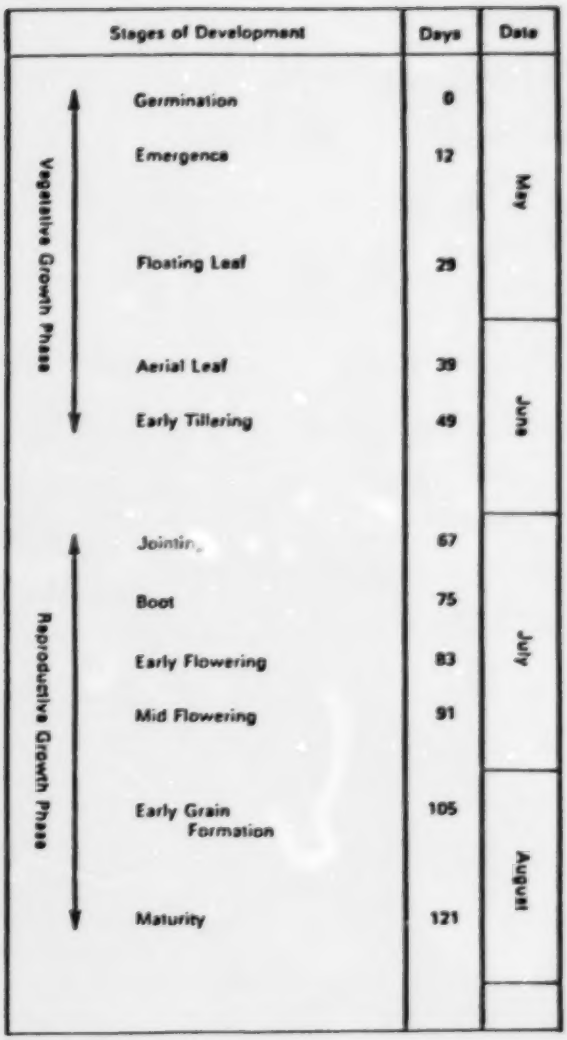


FIGURE 2: Phenology of wild rice (from Oelke, 1982)

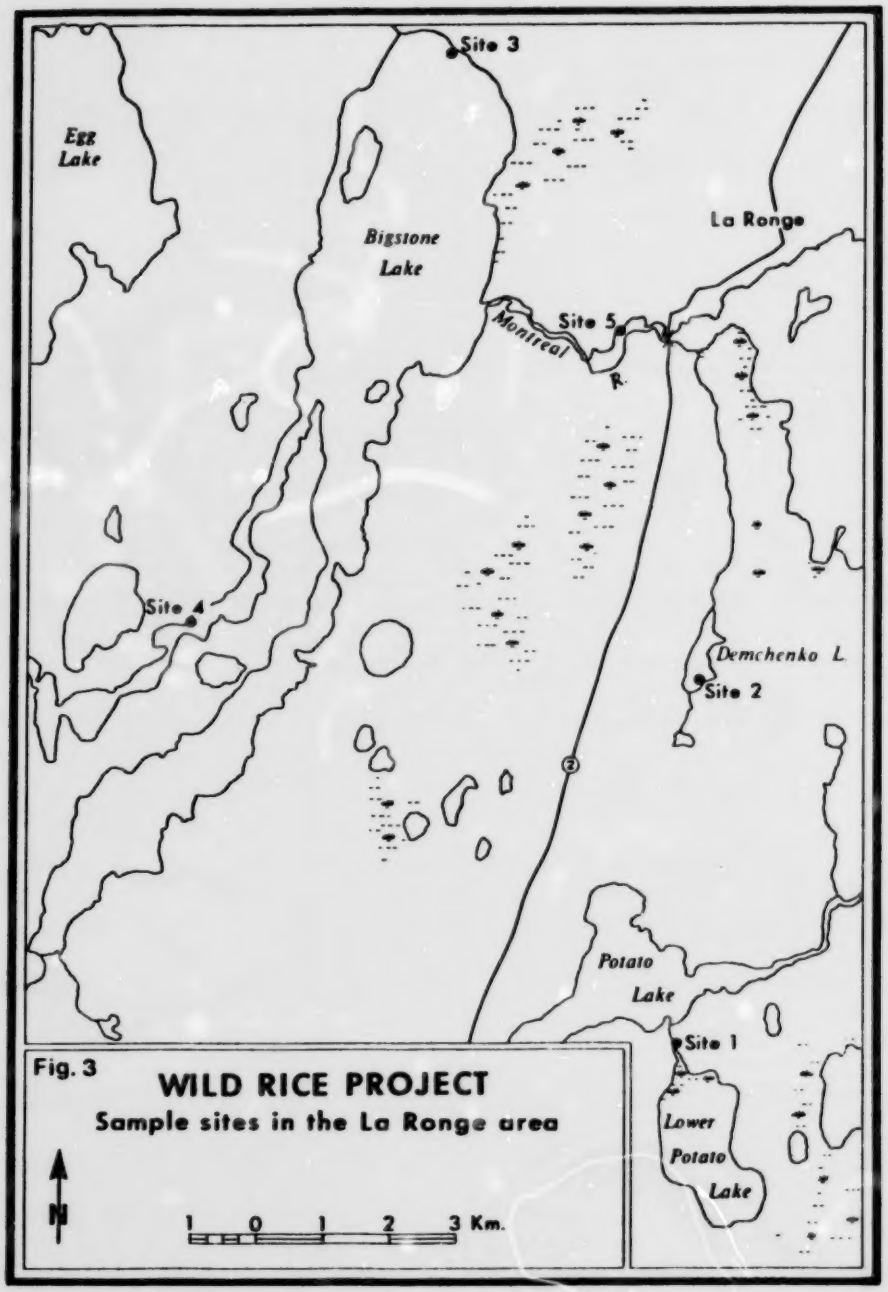


Fig. 3

WILD RICE PROJECT

Sample sites in the La Ronge area

Similarly, during each visit three, 1 litre samples of lake/river water were collected and later tested in the laboratory for macro- and micronutrients. Chemical analyses were conducted for total ammonium, nitrates, sulphates and phosphates, together with iron, manganese, zinc and copper. In addition three samples of sediment, each weighing approximately 0.5 kg, were taken to the laboratory where pH was determined (glass electrode) along with chemical analysis for total nitrate, phosphate and potassium, exchangeable calcium, potassium, sodium and magnesium and the micronutrients, iron, manganese, zinc and copper.

During the first visit (mid-May) to the study area, samples of the previous year's wild rice straw were collected, oven dried, and a known weight was sewn into "decomposition bags". These bags were constructed from nylon netting (2 mm mesh size), submerged in the water and retrieved during successive visits. A total of 24 decomposition bags were used with 6 bags submerged at each site (with the exception of South Bigstone Lake where wild rice had not previously been grown). During each visit one or two decomposition bags were removed along with 3 samples of new wild rice growth. Analyses for the nutrients listed previously for sediment were subsequently performed on both the decomposing and fresh vegetation samples.

At the start of the project three experimental plots

were established in an area where wild rice had previously been seeded (South Bigstone Lake). Each plot consisted of three 10 x 10 m quadrats. Adjacent quadrats were sown at rates of 30, 20 and 10 lbs./acre, respectively. At the end of the growing season, the number of emergent stems was counted to give a measure of wild rice density at all study sites and the number of seeds produced per flower head was calculated. These two measures were combined to give yield data for each site. The effect of the various physical and chemical parameters on yield was subsequently determined by multiple regression techniques.

Results

A. Hydrologic Factors (Table 1)

(i) Water Depth: Water levels tended to rise during the spring and early summer, then fall during mid-summer rising slowly at the end of the growing season. An exception to this pattern is demonstrated by Demchenko Lake which was maintained at consistently high levels during the growing season by beaver dams across its outlet.

(ii) Water Temperature: At the start of the growing season water temperatures averaged 11.4^{o}C. The initial temperature and the rate of change in temperature are closely associated with the size of the water body. Temperatures rose

TABLE I: HYDROLOGIC DATA

		May 20	June 17	July 8	July 29	August 26
(i)	depth (cm)					
	Site 1	67	99	50	41	49
	Site 2	80	86	93	90	90
	Site 3	60	70	65	55	55
	Site 4	58	67	71	55	52
	Site 5	45	57	50	38	-
(ii)	temperature (^{o}C)					
	Site 1	11.5	22.6	21.3	17.9	11.9
	Site 2	12.8	19.3	19.8	19.6	9.1
	Site 3	11.5	17.4	20.9	21.8	8.8
	Site 4	10.0	18.4	22.0	22.1	12.9
	Site 5	11.0	22.0	21.0	20.4	8.2
(iii)	pH					
	Site 1	7.5	7.6	6.6	6.4	6.7
	Site 2	7.4	7.4	7.5	7.4	6.9
	Site 3	7.4	7.2	7.0	7.5	6.8
	Site 4	8.4	8.0	8.1	7.9	7.3
	Site 5	8.2	8.3	8.5	7.9	7.2
(iv)	conductivity (m mhos)					
	Site 1	94	122	115	118	2
	Site 2	159	176	159	168	15
	Site 3	94	156	144	149	10
	Site 4	187	192	191	174	32
	Site 5	194	201	178	151	22
(v)	dissolved oxygen (ppm)					
	Site 1	-	7.65	9.78	5.99	9.72
	Site 2	-	10.06	10.36	11.14	12.96
	Site 3	-	5.56	11.85	12.90	11.88
	Site 4	-	8.75	15.50	11.16	11.63
	Site 5	-	10.80	14.28	9.91	10.70
(vi)	dissolved CO_2 (mg/l)					
	Site 1	132	104	104	252	92
	Site 2	160	172	172	132	172
	Site 3	200	172	160	80	172
	Site 4	104	144	132	64	160
	Site 5	132	200	40	0	120
(vii)	total sulphates (ppm)					
	Site 1	6.30	5.82	6.38	6.31	6.43
	Site 2	6.25	5.60	6.45	6.30	5.75
	Site 3	5.96	5.91	7.00	7.41	13.42
	Site 4	5.66	5.28	5.30	5.25	5.57
	Site 5	6.50	5.40	5.25	5.32	5.12
(viii)	total nitrates (ppm)					
	Site 1	0.05	0.38	0.08	0.44	0.25
	Site 2	0.05	0.24	0.05	0.24	0.23
	Site 3	0.05	0.56	0.05	0.41	0.49
	Site 4	0.05	0.35	0.05	0.34	0.41
	Site 5	0.05	0.62	0.66	0.59	0.39

most rapidly in Potato Lake and Demchenko Lake and in the shallow river water.

(iii) pH and Conductivity: The pH of the water in Potato Lake, Demchenko Lake and at the north end of Bigstone Lake averaged 7.4 at the start of the growing season. This was slightly more acid than the water at sites 4 and 5. Although the pH fluctuated during the growing season, there was a clear trend to more acid conditions by the end of August.

Conductivity measurements ranged from 94 to 194 m mhos in the spring with the highest values recorded in the south end of Bigstone Lake and in the Montreal River. These initial values remained fairly constant during the growing season but dropped markedly at all sites by the end of the summer and ranged from 2 m mhos at Potato Lake to 32 m mhos at site 4.

(iv) Dissolved Oxygen and Dissolved Carbon Dioxide: With the exception of the river (site 5), a slight increase in dissolved oxygen was detected by the end of the growing season. Initial concentrations ranged from 5.56 to 10.80 ppm. Dissolved carbon dioxide levels were more variable, decreasing over the growing at sites 1, 3 and 5 and increasing at sites 2 and 4.

(v) Macronutrients: Total sulphates concentrations were uniform between sites and showed little variation during

the summer averaging about 6 ppm, although at site 3 concentrations increased slightly during mid-summer and peaked at 13.4 ppm in August. Nitrate concentrations were more variable between sites, but all showed a general increase during the growing period.

Nitrogen in the ammonium form could only be detected at very low concentrations (< 0.05 ppm) and this only at the start and end of the study period. Phosphates were below machine detectable concentrations at all times.

(vi) Micronutrients: Concentrations of micronutrients in the lake and river waters were below machine detectable limits. These were set at 1 ppm for iron, 0.01 ppm for manganese, and 0.001 ppm for copper and zinc.

B. Sediment Factors (Table 2)

(i) Sediment pH: Sediment pH was approximately neutral and fluctuated only slightly during the growing season, the greatest range, from pH 6.56 to 6.88, was recorded at site 5.

(ii) Macronutrients: Nitrate concentrations at the end of the growing season were slightly lower than at the start despite a noticeable increase in early summer. No clear trend could be seen in phosphate concentrations, although levels generally peaked in mid-season declining to below initial concentrations at the end of August at sites 1, 2,

TABLE II: SEDIMENT DATA

		May 20	June 17	July 8	July 29	August 26
(i)	pH					
	Site 1	-	6.26	6.31	6.22	6.45
	Site 2	-	6.57	6.47	6.52	6.66
	Site 3	-	6.75	6.33	6.44	6.76
	Site 4	-	6.54	6.43	6.40	6.41
	Site 5	-	6.88	6.63	6.48	6.56
(ii)	Total nitrates (mg/g)					
	Site 1	.07	.07	.08	.05	.07
	Site 2	.10	.13	.09	.07	.08
	Site 3	.04	.20	.05	.05	.04
	Site 4	.09	.09	.11	.08	.08
	Site 5	.05	.18	.05	.04	.05
(iii)	Total phosphates (mg/g)					
	Site 1	.27	.19	.33	.41	.24
	Site 2	.27	.18	.36	.16	.22
	Site 3	.21	.17	.44	.23	.17
	Site 4	.21	.24	.29	.22	.20
	Site 5	.13	.27	.27	.36	.21
(iv)	total potassium (mg/g)					
	Site 1	1.78	1.89	3.04	2.97	1.57
	Site 2	1.96	2.00	1.89	1.88	1.13
	Site 3	2.94	3.61	3.46	3.31	2.17
	Site 4	2.70	4.26	2.02	2.37	2.37
	Site 5	1.69	3.11	1.97	2.28	0.84
(v)	exchangeable magnesium (mg/g)					
	Site 1	29.54	39.16	19.60	38.38	39.45
	Site 2	66.92	35.11	58.78	50.91	58.11
	Site 3	36.95	30.66	41.45	26.26	27.18
	Site 4	88.44	82.10	72.36	66.77	66.37
	Site 5	21.01	23.06	22.65	21.33	20.20
(vi)	exchangeable sodium (mg/g)					
	Site 1	2.38	4.66	3.87	4.53	3.60
	Site 2	2.26	4.24	3.73	3.47	3.60
	Site 3	3.88	8.41	5.20	4.67	5.06
	Site 4	3.59	6.53	4.66	4.53	4.27
	Site 5	2.01	5.86	4.93	3.73	2.53

Table II: Sediment Data (cont'd.)

		May 20	June 17	July 8	July 29	August 26
(vii)	exchangeable potassium (mg/g)					
	Site 1	3.73	3.30	4.67	7.66	3.47
	Site 2	4.78	3.15	3.87	4.00	3.07
	Site 3	8.16	5.87	7.33	6.53	4.93
	Site 4	5.99	6.53	5.46	5.60	4.64
	Site 5	2.41	5.86	6.66	4.93	2.60
(viii)	exchangeable calcium (mg/g)					
	Site 1	433.2	291.8	152.3	325.7	395.5
	Site 2	574.5	314.1	531.9	487.4	349.1
	Site 3	245.7	246.8	255.2	216.9	206.5
	Site 4	727.3	679.2	611.6	699.7	581.7
	Site 5	449.9	533.7	449.1	425.8	223.2
(ix)	exchangeable iron (ppm)					
	Site 1	18	47	22	17	25
	Site 2	25	39	24	20	24
	Site 3	8	19	10	9	10
	Site 4	15	36	21	21	21
	Site 5	11	19	12	12	9
(x)	exchangeable manganese (ppm)					
	Site 1	3.27	4.07	3.35	4.00	2.96
	Site 2	4.44	4.95	1.96	2.33	2.80
	Site 3	1.92	3.66	2.56	2.70	2.70
	Site 4	5.84	4.98	3.90	6.76	4.10
	Site 5	4.66	5.13	4.83	6.93	3.26
(xi)	exchangeable copper (ppm)					
	Site 1	.03	.04	.04	.04	.03
	Site 2	.02	.02	.02	.02	.02
	Site 3	.03	.03	.03	.02	.03
	Site 4	.01	.01	.01	.01	.01
	Site 5	.04	.05	.04	.03	.01
(xii)	exchangeable zinc (ppm)					
	Site 1	.19	.25	.27	.30	.32
	Site 2	.32	.33	.39	.49	.44
	Site 3	.25	.27	.34	.28	.34
	Site 4	.07	.09	.20	.13	.14
	Site 5	.19	.15	.15	.20	.19

3 and 4. Exchangeable magnesium concentrations remained uniform at site 4 throughout the summer fluctuating between 21.0 and 22.6 mg g^{-1}. At sites 2, 3 and 4 concentrations decreased during the summer while at site 1 an increase was recorded. Exchangeable sodium peaked in the early summer, exchangeable potassium fluctuated noticeably throughout the season while exchangeable calcium declined from peak concentrations in the spring.

(iii) Micronutrients: Micronutrient concentrations showed a variety of trends. Iron peaked in mid-June, dropping back to initial levels by July which were maintained for the remainder of the season. For manganese, concentrations at site 1 rose and fell continually, at sites 2 and 3 concentrations peaked in early summer then fell and steadied for the duration of the season. At sites 4 and 5 a late summer peak was recorded. Copper concentrations rose initially before declining steadily over the summer, whereas for zinc a gradual increase in concentration was detected.

C. Decomposing Plant Materials (Table 3)

(i) Reduction of Straw by Decomposition: Average weight loss at the four sites over the period May 20 to June 17 was 32%, with a further 5% reduction occurring over the ensuing period ending July 8. Initial losses were greatest in the river (site 5). A small amount of straw continued to be removed at sites 2 and 5 until the end of July. The period

TABLE III: CHEMICAL ANALYSIS OF DECOMPOSING STRAW

		May 20	June 17	July 8	July 29	August 26
(i)	weight of original straw remaining in decomposition bag (%)					
	Site 1	-	77.0	70.0	76.8	85.2
	Site 2	-	67.7	63.2	62.9	75.8
	Site 3	-	72.0	65.6	69.9	79.0
	Site 5	-	55.0	54.5	47.3	-
(ii)	total nitrogen (%)					
	Site 1	.76	.56	.79	1.13	1.23
	Site 2	.62	.86	.93	.93	1.28
	Site 3	.77	1.05	.94	1.09	1.12
	Site 5	.88	.85	.89	1.16	-
(iii)	total phosphorous (mg/g)					
	Site 1	-	.24	.29	.51	.50
	Site 2	-	.27	.45	.35	.49
	Site 3	-	.50	.51	.59	.56
	Site 5	-	.39	.42	.50	-
(iv)	total magnesium (mg/g)					
	Site 1	-	.65	.72	.93	.79
	Site 2	-	.59	.80	.64	.93
	Site 3	-	.87	.84	1.02	.70
	Site 5	-	.73	.93	1.00	-
(v)	total sodium (mg/g)					
	Site 1	-	.19	.19	.20	.30
	Site 2	-	.20	.20	.23	.21
	Site 3	-	.19	.20	.34	.30
	Site 5	-	.28	.20	.19	-
(vi)	total potassium (mg/g)					
	Site 1	-	.28	.29	.34	.69
	Site 2	-	.29	.30	.46	.41
	Site 3	-	.48	.39	.48	.60
	Site 5	-	.18	.44	.48	-

Table III: Chemical nalysis of Decomposing Straw (cont'd.)

		May 20	June 17	July 8	July 29	August 26
(vii)	total calcium (mg/g)					
	Site 1	-	4.90	4.46	7.12	5.35
	Site 2	-	5.95	5.85	4.87	7.31
	Site 3	-	6.27	6.31	5.84	5.30
	Site 5	-	6.82	6.12	6.52	-
(viii)	total iron (ppm)					
	Site 1	1077	1203	1779	2968	5501
	Site 2	1967	1852	2850	2591	3391
	Site 3	1675	2751	-	2865	4250
	Site 5	739	1383	1617	2970	-
(ix)	total manganese (ppm)					
	Site 1	292	157	187	113	327
	Site 2	99	156	145	292	123
	Site 3	88	290	-	127	90
	Site 5	241	175	357	486	-
(x)	total zinc (ppm)					
	Site 1	12.8	15.7	13.9	19.9	38.7
	Site 2	13.1	8.8	12.1	17.4	31.9
	Site 3	17.1	24.1	16.6	15.2	22.1
	Site 5	14.5	16.6	15.2	15.6	-

July 29 to August 26 was characterised by a gain in weight of some 10%, presumably because of trapped sediment accumulating in the debris.

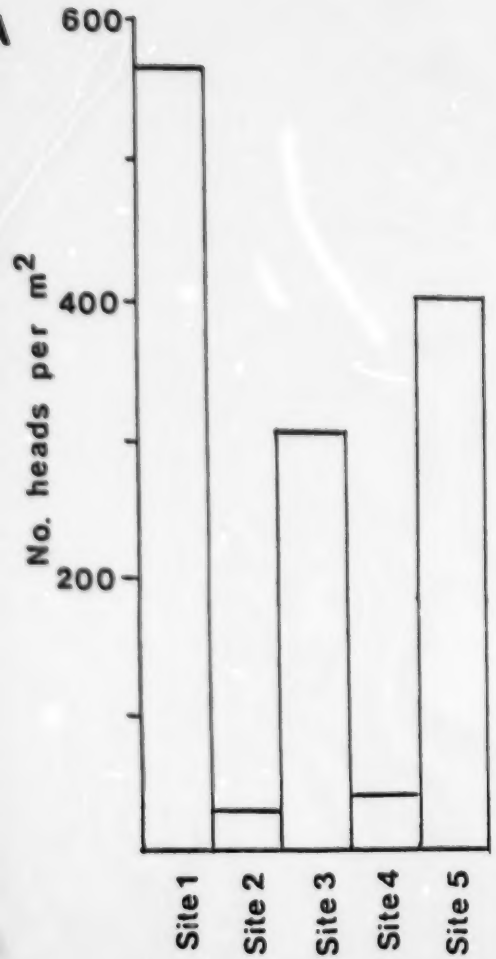
(ii) Macronutrients: Percent nitrogen content of the decomposing straw increased at all sites over the summer. Initial levels averaged 0.76% between sites but by the end of August the comparative value was 1.12%. Little variation occurred between sites, although nitrogen levels were depressed initially, rising again as the summer progressed. Phosphorous concentrations in the straw likewise increased over the summer, although the trend was not regular at all sites. For magnesium, a general increase in concentrations was recorded at sites 1, 2 and 5, but at site 3 levels decreased from .87 mg/g in early summer to .70 mg/g in August. Sodium and potassium concentrations similarly increased with decomposition, although calcium levels were more variable.

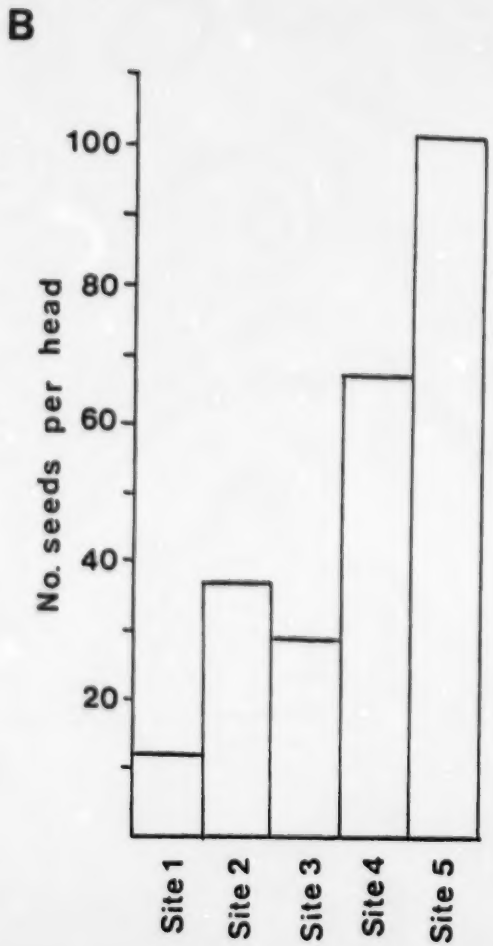
(iii) Micronutrients: Concentrations of iron in the decomposing wild rice straw increased over the study period. This was most pronounced in Potato Lake where initial iron concentrations were 1077 ppm but reached 5500 ppm by the end of August. No uniform trend could be discerned for manganese, and with the exception of site 5 where concentrations were basically stable over the season, the level of zinc in the straw increased over time.

D. Fresh Plant Materials (Table 4)

(i) Yield: Data relating to wild rice yields are presented in Figure 4. The highest density of flower heads occurred at Potato Lake where 562 heads/m^2 were recorded. High densities were similarly found at the river site (400 heads/m^2) and at the north end of Bigstone Lake (304 heads/m^2). Demchenko Lake and the south end of Bigstone Lake were considerably less productive with 29 and 39 heads/m^2, respectively. However, the number of seeds produced per flower head differed significantly between sites. At Potato Lake this averaged only 12. At Demchenko Lake and north Bigstone Lake the number of seeds per head averaged 36 and 28, respectively, increasing to 67 seeds per head at South Bigstone with 101 seeds per head recorded at the river site. Based on data calculated from samples of the previous year's grain, the average fresh weight of an individual wild rice grain is 0.0771 g. This gave yields ranging from 805 kg/ha at Demchenko Lake to 31,148 kg/ha at the river site. Yield in Potato Lake was estimated at 5,200 kg/ha, and at the north end of Bigstone Lake at 6563 kg/ha. At south Bigstone Lake yield was estimated at 2015 kg/ha. However, this latter site represented the trial plots which were sown for the first time at the start of the current growing season. Three sowing densities were used, equivalent to 10, 20 and 30 kg/ha. Germination tests subsequently conducted in the laboratory showed that the grain sown had an average viability of 80%.

FIGURE 4: Density of flower heads (A), number of seeds per head (B) and yield of rice grain (C) at the end of the growing season.





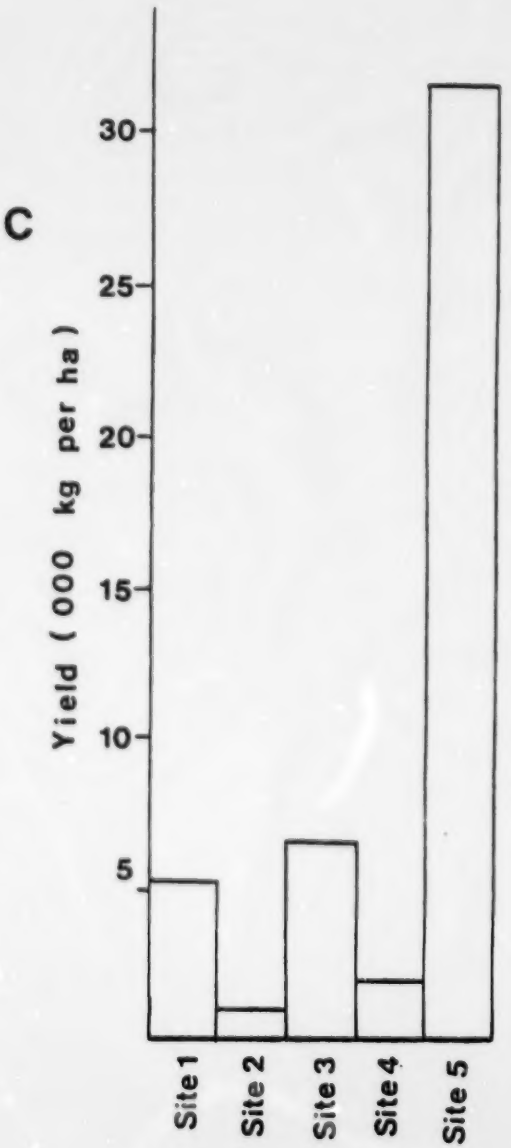


TABLE IV: CHEMICAL ANALYSIS OF FRESHLY HARVESTED RICE

	June 17	July 8	July 29	August 26
(i) total nitrogen (%)				
Site 1	2.36	1.60	1.41	1.15
Site 2	-	3.17	2.45	1.75
Site 3	2.83	2.96	2.86	2.59
Site 4	-	2.72	2.43	2.07
Site 5	2.60	2.60	2.02	1.74
(ii) total phosphorous (mg/g)				
Site 1	2.82	1.32	1.20	1.10
Site 2	3.56	3.27	2.18	1.32
Site 3	4.51	3.46	2.51	1.54
Site 4	-	2.96	2.80	2.12
Site 5	5.63	3.86	2.88	1.70
(iii) total magnesium (mg/g)				
Site 1	2.31	1.95	1.58	1.34
Site 2	2.89	2.90	2.04	1.98
Site 3	2.91	1.74	1.48	1.30
Site 4	-	1.97	1.63	1.35
Site 5	2.97	1.99	1.49	1.69
(iv) total sodium (mg/g)				
Site 1	5.40	5.46	4.62	4.48
Site 2	8.40	4.87	5.45	3.87
Site 3	7.05	5.93	5.24	4.57
Site 4	-	5.15	5.14	4.82
Site 5	6.75	6.81	6.85	5.50
(v) total potassium (mg/g)				
Site 1	21.5	11.9	10.7	10.2
Site 2	26.8	28.6	31.1	20.3
Site 3	23.0	25.0	15.9	12.4
Site 4	-	18.6	24.3	19.3
Site 5	22.5	20.3	14.7	9.2
(vi) total calcium (mg/g)				
Site 1	5.54	6.44	5.40	4.38
Site 2	6.73	6.98	5.23	4.38
Site 3	6.57	4.97	4.26	4.98
Site 4	-	6.08	5.07	3.76
Site 5	9.76	5.91	5.01	5.27

Table IV: Chemical Analysis of Freshly Harvested Rice (cont'd.)

		June 17	July 8	July 29	August 26
(vii)	total iron (ppm)				
	Site 1	3968	3340	2691	2668
	Site 2	3601	3172	3019	2391
	Site 3	2996	2575	2171	2028
	Site 4	-	3859	2583	1658
	Site 5	6189	4559	2999	2033
(viii)	total manganese (ppm)				
	Site 1	323	288	255	245
	Site 2	499	322	225	139
	Site 3	252	235	156	122
	Site 4	-	276	268	203
	Site 5	501	399	305	224
(ix)	total zinc (ppm)				
	Site 1	37.7	27.8	21.6	19.4
	Site 2	54.4	30.8	26.2	31.7
	Site 3	42.7	27.4	27.0	26.9
	Site 4	-	25.1	18.2	18.1
	Site 5	36.3	19.6	17.2	23.2

No significant difference in yield could be found at the various trial plots. Using an average sowing density of 20 kg/ha, the grain return on this site was approximately 100 times the sowing rate. It is expected that yields might increase at this site as shattered seed supplements the initial sowing.

(ii) Macronutrients: The percentage of nitrogen in the freshly harvested wild rice declined over the growing season at all sites. This decrease was most pronounced at Demchenko Lake, falling from 32% to 1.8%. Phosphorous content of the rice plants similarly declined over the growing season, particularly at the river site. A characteristic decline was also noted for magnesium, sodium, potassium, and calcium.

(iii) Micronutrients: The concentration of iron, manganese and zinc in the growing plant tissues similarly declined over the growing period. This suggests that the greatest rate of nutrient uptake occurs early in the season when growth is rapid. No measurable copper could be detected in the fresh plant tissue.

Statistical Analyses and Conclusions

The data collected over the summer were first averaged to give a mean value for each variable for each site. With

wild rice yield as the dependent variable, selected mean data were subsequently used in bivariate correlation and multiple regression analyses. The results of the correlation analysis are given in Table 5. A highly significant ($r = 0.959$, $p < 0.01$) correlation was found between plant yield and the pH of the water indicating that less acidic water might favour increased yields. Similarly, conductivity of the water was positively correlated ($r = 0.845$, $p < 0.05$). However, as dissolved carbon dioxide levels increased in the water a decrease in yield occurred ($r = -0.820$, $p < 0.05$). Dissolved oxygen ($r = 0.734$) and total nitrates ($r = 0.692$) might also influence rice yields although these factors were significant only at the 0.1 level. Only one sediment variable, exchangeable manganese ($r = 0.821$, $p < 0.01$) was significantly correlated with rice yields.

The phenological development of wild rice shown in Figure 2 indicates vegetative growth phase of up to 50 days during which time tillering occurs. Flowering commences 80 to 90 days after germination with grain formation starting approximately 20 days later. Since the number of stems in an area resulting from germination and tillering is determined in the early part of the growing season, environmental conditions in May and June have been related to stem density using multiple regression analysis. The results (Table 6)

TABLE 5: CORRELATION COEFFICIENTS FOR WILD RICE YIELDS WITH SELECTED INDEPENDENT VARIABLES (n = 15)

Independent Variable	r
A. Water	
Depth	-0.624
Temperature	0.078
pH	0.959***
Conductivity	0.845**
Dissolved Oxygen	0.734*
Dissolved Carbon Dioxide	-0.820**
Total Sulphates	-0.600
Total Nitrates	0.692*
B. Sediment	
pH	0.610
Total Nitrates	-0.146
Total Phosphates	-0.490
Total Potassium	0.046
Exchangeable Magnesium	0.232
Exchangeable Potassium	0.077
Exchangeable Calcium	-0.600
Exchangeable Iron	-0.432
Exchangeable Manganese	0.821**
Exchangeable Copper	-0.374
Exchangeable Zinc	-0.644
Exchangeable Sodium	-0.313

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

TABLE 6: RESULTS OF STEPWISE MULTIPLE REGRESSION ANALYSIS* BETWEEN STAGES OF PLANT DEVELOPMENT AND ENVIRONMENTAL CONDITIONS THROUGH THE GROWING SEASON (n = 12[a])

Monitoring Date	Stage of Plant Development	Variables in Equation	R	R^2	F
May 20	Germination	(A) Water pH	0.597	0.356	5.55**
		(B) Sediment Iron	0.886	0.785	16.51
		(C) Water Conductivity	0.968	0.938	40.74
		x = 2.639 + 0.195 (A) - 0.001 (B) + 0.108 (C)			
June 17	Tillering	(A) Sediment Magnesium	0.789	0.623	16.57
		(B) Sediment Zinc	0.880	0.775	15.58
		(C) Sediment Potassium	0.937	0.879	19.40
		(D) Water pH	0.957	0.916	19.22
		x = 0.888 - 0.001 (A) + 1.141 (B) - 0.001 (C) - 0.015 (D)			
July 9	Flowering	(A) Sediment Zinc	0.936	0.876	70.93
		(B) Water Temperature	0.977	0.956	98.72
		x = 228.30 + 13481.59 (A) - 4.75 (B)			
August 26	Seed Set	(A) Water Carbon Dioxide	0.836	0.700	23.39
		(B) Water Oxygen	0.924	0.854	26.36
		(C) Water Temperature	0.985	0.971	91.62
		x = 1557.23 - 87.64 (A) - 9.34 (B) - 2.57 (C)			

*Variables added until R^2 exceeded 0.900

** $p \leq 0.05$ other F values $p \leq 0.01$

[a]Sites 1, 2, 3 and 5

indicate that the initial germination response may be affected by the acidity of the water, its conductivity and the concentration of iron in the sediment. Later in the year tillering is stimulated by low levels of exchangeable magnesium and potassium in the sediments, an increase in available zinc and a slight increase in the acidity of the water. Environmental conditions during late July and August have been used as indicators of flowering activity and subsequent seed production. Reproductive growth appears to be controlled initially by high zinc levels in association with cooler water temperatures. During August increased seed production was associated with falling water temperatures and decreased oxygen and carbon dioxide concentrations in the water.

CONCLUSIONS

Because of prohibitive analytical costs, it was only possible to conduct tests at five sites. Such a low number of cases can hardly justify the use of powerful statistical techniques. Hence, the preceding statistical analyses should be treated with caution. Similarly, no account has been made of non-aquatic factors such as air temperature, precipitation, etc., which could significantly affect plant development, particularly flowering and seed set. However, it would appear from this study that some of the more readily and cheaply monitored variables could provide an indication of

wild rice potential for sites in northern Saskatchewan. Although it would be preferable to extend the full range of chemical analyses to a greater number of lakes and rivers, pH, conductivity, dissolved carbon dioxide and dissolved oxygen might form the basis of a preliminary site evaluation programme of shallow water environments.

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ANALYSIS OF THE HABITAT POTENTIAL OF WILD-RICE (*Zizania palustris* L.) IN NORTHERN SASKATCHEWAN

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INTRODUCTION

The commercial production of wild-rice in Saskatchewan has recently undergone significant proliferation. Increased harvest is due in part to government assistance and encouragement in the acquisition of permits and establishment of new wild-rice stands (Figure 1). The current study, begun in June, 1983, will assist in determining both distribution of activity and the potential size of the industry by examining the habitat potential of the introduced plant. Included in the present article is a brief description of the approach being used, as well as an indication of some preliminary findings. Completion date is scheduled for September, 1984.

OBJECTIVES AND METHODS

The overall aim is to identify the conditions which define suitable locations for introducing wild-rice and successfully establishing new stands. This is a necessary first step toward estimating the total area involved and outlining the distribution of wild-rice habitat in northern Saskatchewan. The study utilizes the former Northern

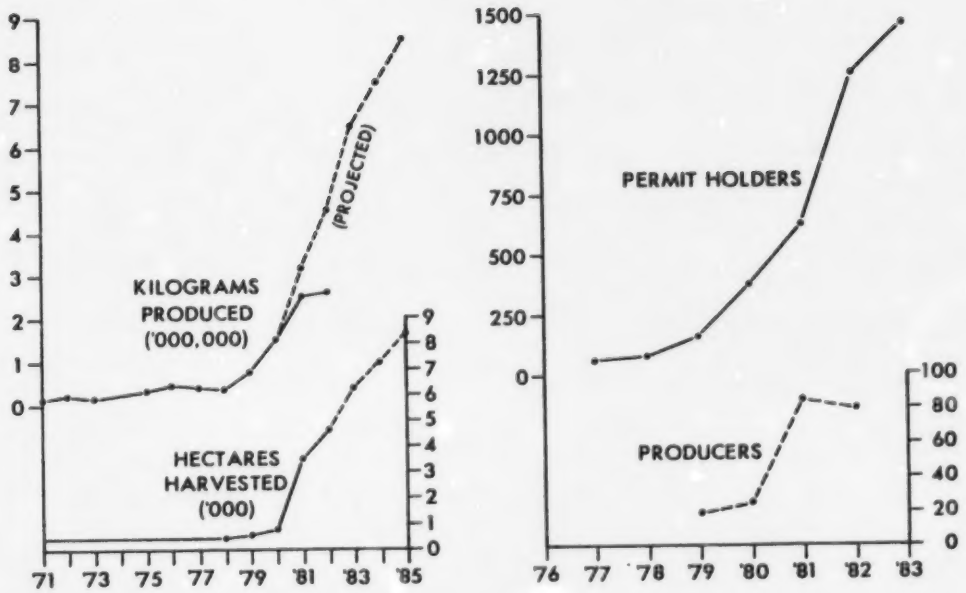

FIGURE 1. Recent trend in wild-rice production in northern Saskatchewan and numbers of persons involved. (Source: provincial gov't. statistics)

Administration District boundary (approximated by 54°N) as the southern limit of the region of interest.

Existing wild-rice stands serve as a basis for analysis of suitable growing conditions. Therefore it was necessary to map known stand locations and areas under permit to understand the present extent of the wild-rice growing region. This provided a basis for selection of sampling sites. A search of permit files in the Land Management Division,

Resources Branch, Department of Parks and Renewable Resources, Prince Albert was conducted in June, 1983.

Fieldwork was carried out during mid-August to early September, 1983, so as to coincide with onset of seed ripening. A total of 324 stations were taken at 36 widely dispersed stands, with 12 sites in each of west, central and eastern portions of the region. Table 1 summarizes the plant and environmental variables measured on site or from collected samples.

TABLE 1. Variables measured for 36 northern Saskatchewan wild-rice stands (August, 1983)

Water	Sediment	Plant Growth
- depth	- depth	- associated aquatic plants present
- temperature	- pH	Wild-rice
- dissolved O_2	- % organic matter	- biomass
- pH	- macronutrients	- density
- alkalinity	- wild-rice thatch	- stem, flower and leaf dimensions
		- seed production

The field data will allow variations in wild-rice growth to be examined in terms of variations in habitat conditions in order to define optimum habitat. As well, measurements of the wild-rice plants themselves may indicate whether both varieties of the species *Zizania palustris* (Northern and

Interior wild-rice) are distinguishable in Saskatchewan. For each variety optimum habitat conditions, particularly water depths, differ.

Length and temperature regime of the growing season are considered critical factors in determining a northern boundary for the Saskatchewan wild-rice region. Although the data base is expected to be small, information on dates of seed ripening and other major growth stages is being sought from various sources, including growers. Comparison will be made with climatological data to establish an effective northern limit.

The final phase of the study is mapping the distribution of potential habitat and estimating the areal magnitude. Due to the size of the region satellite (LANDSAT) images will be employed in delineating subregions. These will differ in terms of variables (e.g., lake size, percent surface water, topography and surficial geology) which will affect the proportion potentially suitable for wild-rice. The use of a digital analyzing system designed for satellite data will also be tested in this phase. The system allows areas to be evaluated using the concept of spectral signatures to identify, map and measure specific areas of interest.

PRELIMINARY RESULTS

1. Distribution of wild-rice stands and permits: The pattern of wild-rice permit locations is shown in Figure 2.

FIGURE 2

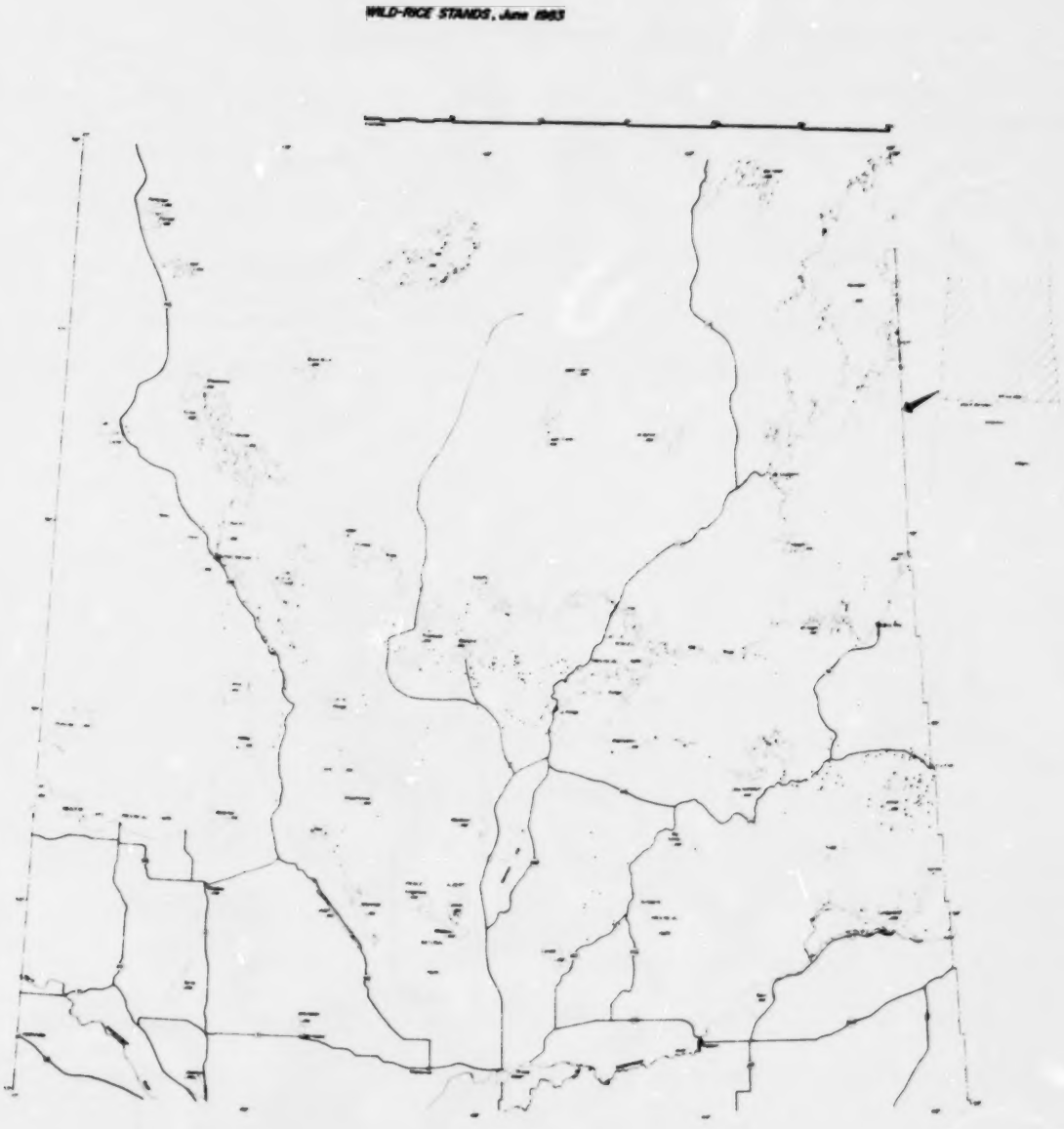

FIGURE 3

In some cases dots indicate the general vicinity of several neighbouring sites held under a single permit. A large block near La Ronge is used by La Ronge Industries Limited and may be considered an area permit containing numerous stands. New permit applications are being continually approved and the map is current only to June, 1983. The majority of permits are found south of the Churchill River. A certain amount of concentration in the vicinity of major road access corridors can be seen, and this is much more evident on large scale maps showing minor roads.

Many of the permit locations remain to be seeded, while at others initial attempts to establish wild-rice have not necessarily been successful. Figure 3 shows the distribution of known wild-rice stands as of the 1982 season. Growers report seeding success and quantities harvested on forms stored in the permit files. (As yet the reporting is on a voluntary basis rather than a prerequisite for permit renewal). Mr. K. Parada, of La Ronge Industries Limited, and Mr. P. Orcajada, provincial wild-rice agrologist, provided additional locations. Commercial production for the 1983 season would not be expected from all locations in Figure 3 because of newer sites the crop would undoubtedly be left to reseed a denser or larger stand.

2. Data from fieldwork and sample measurements: Much data remains to be derived or tabulated prior to analysis. However, Table 2 provides an initial comparison of variation within the region. The most notable differences appear as shallower depth values and greater numbers of seeds on each flower head for the 12 sites (108 sample stations in total) in the western portion of the region. Although more detailed statistical testing is needed, the contention that the Interior wild-rice variety is prevalent in that part of the region may prove valid.

TABLE 2. Comparison of ranges (mean minimums and maximums) for water depth and pH, wild-rice density and seed production in the three principal sampling areas (12 sites per area)

Variable	West	Central	East
water depth (cm)	43 - 85	82 - 132	88 - 131
water pH	7.7 -8.3	7.5 - 8.0	7.0 - 7.6
wild-rice density (seed heads/m^2)	15 -136	13 - 160	14 - 102
seed production (no./head)	18 -122	10 - 66	10 - 55

This type of information will be of significance for growers because of the possibility of harvesting difficulty in shallow water. In a number of the sites visited a noticeable proportion of the plants were completing their growth

on exposed mud or very shallow water near shore. This may impede use of air boats for harvesting. Where harvest had begun, it was noted that stem breakage and flattening of the plants was occurring after only one or two passes of the harvester. A further implication concerns the use of seed from one area being used to establish new stands elsewhere. It is possible that success may be enhanced by matching habitat conditions more closely between new sites and parent stands when acquiring seed.

REPORT

ON

A NEW APPROACH TO WILD RICE HARVESTING IN NORTHERN SASKATCHEWAN

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For presentation at the Saskatchewan Wild Rice Association meeting. February 17-18, 1984.
Prince Albert, Sask.

SUMMARY:

This paper describes the design, fabrication and testing of a wild rice harvester assisted by a powered reel for Northern Saskatchewan.

A NEW APPROACH TO WILD RICE HARVESTING IN NORTHERN SASKATCHEWAN

BY

R.L. KUSHWAHA G.E. MILLER P.G. ORCAJADA

Wild rice (Zizania Aquatica L.) is neither the wild form of common white rice (oryza sativa L.) nor related to it. In similarity, they both grow in water and are tillering annual cereals. In contrast, wild rice grows in a colder climate, is cross pollinated and produces grain with higher protein, 14 percent compared to 8 percent (Anderson, 1976).

In Northern Saskatchewan the wild rice was introduced in 1935. However, in the last six years, from a 1978 production of 27,470 kg, the yield it rose to 250,210 kg (551,610 kg) in 1983. At the present price of $3.30/kg ($1.50/lb.) of green rice, it represents a substantial income for the economy of the region.

The wild rice in Northern Saskatchewan is grown in lakes. Because of uneven ripening of the rice heads and its easy shattering characteristics, the rice is harvested using air boats with front mounted buckets by making multipasses and by traditional hand harvesting. The average production ranges from 84 kg to 112 kg/ha (90-125 lb/acre) which represents only one fourth or one fifth of the total yield. Because of the type of equipment used for harvesting wild rice, only 10 to 25 percent of the crop can be harvested. (Orcajada, 1982).

Therefore, if the harvesting system can be improved to at least double the harvesting efficiency, the production will double without increasing the area under production. Thus, the objectives of this project were to develop and test a wild rice harvesting mechanism to

achieve higher rice intake. This will also reduce reseeding thereby minimizing overcrowding and straw build-up in the rice areas of the lakes.

Physiology and Harvesting

Wild rice is an annual crop which grows from seeds on the lake bottom. Germination takes place when water temperature is around 5°C. The proper depth of water is between 0.6 to 1.2 m (2-4 ft) and the water level should remain stable. The plants grow from a stage of floating leaves to approximately 0.6 m to 2.1 m (2-7 ft) above water level (Neilson, 1964).

Seeds mature from the top of the panicle and proceed downward. Approximately ten percent of the seeds mature at a time so that the harvesting operation needs to be repeated several times to be able to harvest most of the grain. Harvesting in Northern Saskatchewan generally starts around the last week of August and continues until the last week of September.

There are two common method of harvesting practised in Northern Saskatchewan. These are as follows:

1. The traditional hand harvesting
2. Mechanical harvesting.

The traditional hand harvesting method involves two persons, one to paddle a canoe and the other to bend the stalks over the canoe and simultaneously tap the panicles to dislodge the rice.

Mechanical harvesting uses an airboat with a 2.44 m to 3.05 m (8-10 ft) collecting bucket or table mounted at the front. The boats

are operated between 16 km/h and 24 km/h (10-15 mph). The impact to the stalks by the bucket dislodges the rice kernels and some of these fall into the bucket. Depending upon the crop stand and speed of operation, a harvester unit can harvest between 80 kg to 220 kg of green rice in an hour.

The production of rice in Northern Saskatchewan has been increasing every year. In 1980, it is estimated that the Saskatchewan production was about 12 percent of the Canadian production and about three percent of the North American production (Orcajada, 1980). The United States is so far the recognized leader in this industry where the rice has been demesticated since 1960 (Schertz et al 1978) and is mainly grown in Northern Minnesota with some in Wisconsin. Harvesting is carried out with combines with modified support system.

Table I shows the production figures since 1978. There has been substantial increase in the wild rice yield until year 1981. However, the increase in production declined considerably in 1982 and 1983 in spite of the increase in the area seeded. The reason for this decline in increase of the yield can be attributed to climatic factors and mainly to poor harvesting efficiency. Therefore, it is necessary to design a system which will improve the harvesting efficiency to keep the wild rice industry moving ahead in Northern Saskatchewan.

The wild rice industry in Northern Saskatchewan is currently made up of 81 producers, owning 71 mechanical harvesters. The number of producers and the area seeded is increasing each year. Recently, a wild rice processing plant with a capacity of 227 kg/h (500 lb/hr) of processed rice was opened at La Ronge, Sasktachewan.

The New Approach

The new approach consists of a powered reel operating at a

suitable speed to dislodge the rice kernels without injuring the plants and collecting the falling rice. Although this approach is new for wild rice grown in Northern Saskatchewan in lakes, however, it has been used for domesticated rice grown in Minnesota (Schertz et al. 1978) during early years of production for multi-pass harvesting. The design includes a powered reel, rice-catching troughs and an auger assembled on a 2.44 m wide existing bucket of an air boat. The air boat, 4.88 m (16 ft) long was powered by an air cooled 1600 cc Subaru motor equipped with 1.32 m propeller.

Powered reeled:

The limiting factor was the size of the bucket. Therefore, a five-bat, one metre diameter reel was fabricated as shown in Fig 1. The detailed drawing of the reel is shown in Fig 1A. In order to minimize wrapping of stalks, the area between the centre and the bats was covered with a 13 mm square wire mesh. Rubber belting flaps were added on to bats for gentle impact to rice heads. Light aluminum tubing was used in fabrication to keep the weight to a minimum.

A power-steering pump with constant displacement was used to drive a hydraulic motor to power the reel. The reel speed was kept 25 percent higher than the operating speed of the boat in order to impart a gentle impact to to rice heads. The desired reel speed was obtained with V-belt and a set of V-pulleys.

Design Parameters:

The reel mechanism was designed to operate at a travel speed of 12 km/h (7.5 mph). For optimum performance of the reel in grain harvesting, it is recommended to have a reel tip speed about 1:1 to 1.2 times the travel speed. This ratio is called reel index. In order to impart a gentle impact to rice heads, the reel index of 1.25 was proposed.

Therefore, at the travel speed of 12 km/h, for the one metre diameter reel, a reel speed of 80 rpm was obtained. Listed belwo are the rpm of the reel at various possible travel speeds for 1.25 reel index.

Travel Speed km/h (mph)	Reel Speed rpm	Reel Index at 80 rpm
10 (6.2)	66.3	1.50
11 (6.8)	72.9	1.38
12 (7.5)	79.6	1.25
13 (8.1)	86.2	1.15
14 (8.7)	92.8	1.07

In order to maintain the reel index of 1.25 for proper harvesting, the travel speed must be maintained close to the design speed.

Catching troughs:

The catching troughs (Fig 1A) 500 mm long and 75 mm wide were attached in front of the bucket (Fig 2). The troughs were pointed and spaced at 50 mm apart to permit the rice stalks to pass between the troughs.

Unloading device:

With the reel and the troughs attached to the bucket, it was not possible to scoop out the harvested rice from the front of the bucket. A 178 mm auger was mounted in the bucket (Fig 3) with a gate at one end. The auger was hand operated and the green rice could either be bagged or dumped into the support boat.

Field test:

The completed unit (Fig 4) was tested for its functional evaluation during the 1983 harvesting season. The unit was operated at a speed between 10-12 km/h during rice harvesting.

The reel at 25 percent higher speed proved effective in detaching rice kernels without damaging the stalks. The catching troughs collected most of the rice falling from the heads and the spacing between the troughs was just sufficient to let the stalks pass through and slither as the harvester moved forward. Although it was the fourth pass on the test patch with the new harvester, the quantity of rice collected was considerably greater than the quantity of rice harvested with the conventional harvester. A long duration test to determine the harvesting efficiency of the new design and to compare it with the conventional harvesters was not conducted, because of instability of the boat-hull. A considerable interest has been shown by the producers in the area and we plan to continue the project during 1984 harvesting season.

Future Research:

1. Design and fabrication of a complete harvester supported on pontoons.

2. Intensive testing and evaluation of the two harvesters during 1984 harvesting season.

3. Comparative evaluation of harvesting efficiency with the conventional bucket-harvester.

Production Projection:

Fig 5 shows the actual production for years 1978-1983 and the

production estimates reported by Orcajada (1980). Orcajada (1980) based his estimates on the following assumptions:

1. Available area for expansion to as much as 13,000 ha (32,000 acre).

2. Continued interest in productoin of wild rice on the part of qualified northerners.

3. Continuous, effective and intensive extension program by the Government.

4. Serious and continuous research program undertaken or supported by the Government in production, harvesting, processing and marketing of wild rice.

5. Government policies to financially support producers by grants for harvesting equipment and assistance in marketing.

Assuming these factors in place, the 1982 production could have been a million pounds. However, the actual production was just above half of the projected figure. The 1983 production increased by less than six percent. Estimating a 10 percent increase for the years 1984 and 1985, the 1985 production will be about 668,000 lb (303,000 kg), well below the estimates.

After extensive testing of the new harvester in 1984, and estimating its harvesting efficiency as twice that of the conventional harvester, if only half the rice crop is harvested with the new harvester, the 1985 production would reach nearly a million pounds. Thus, the new harvester has the potential to change the slope of the production curve nearly in line with original estimates of Orcajada (1980) and match the production estimate of 1982, just three years

later, in 1985.

Acknowledgements

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TABLE I

NORTHERN SASKATCHEWAN

WILD RICE PRODUCTION

YEAR	GREEN RICE PRODUCED		PERCENT
	kg	lbs	CHANGE
1978	27,470	60,500	-
1979	72,640	160,000	+164.4
1980	145.870	321,300	+100.8
1981	233,265	513,800	+ 59.9
1982	236,400	520,700	+ 1.3
1983	250,210	551,610	+ 5.9

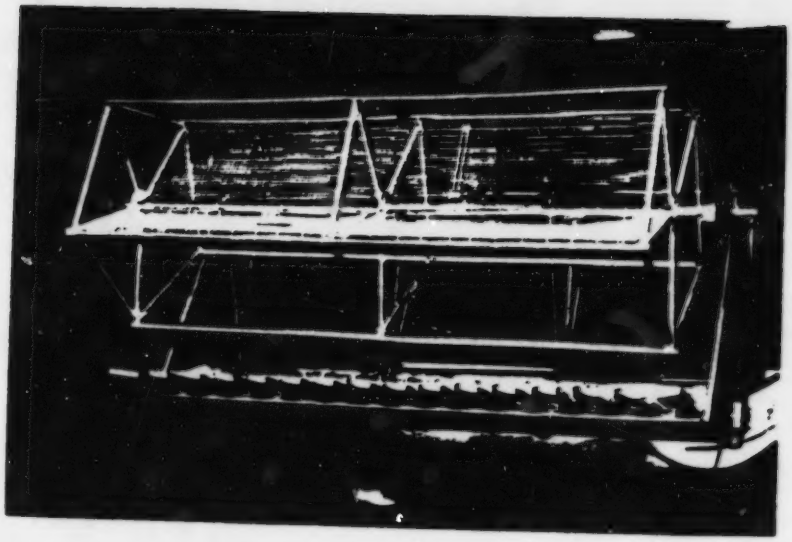


Figure 1. The Powered reel

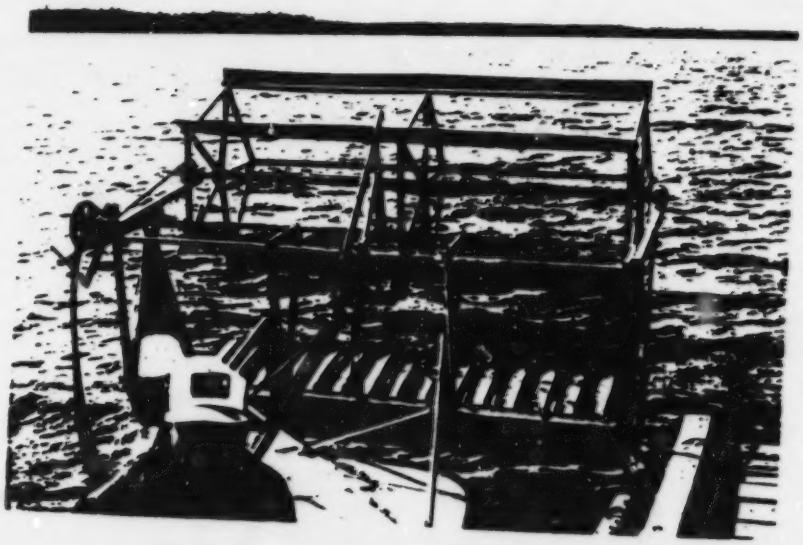
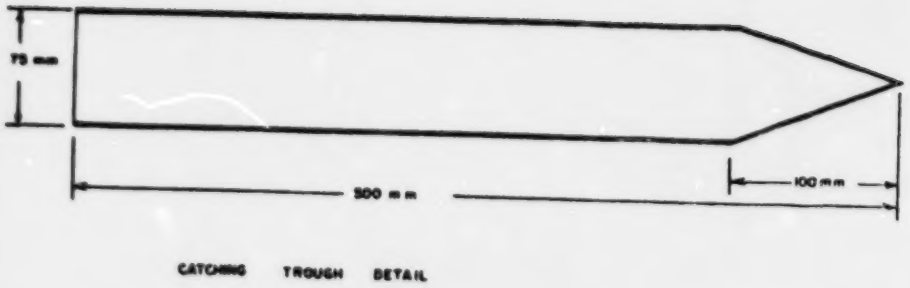


Figure 2. Rice catching troughs and Powered reel mounted on the harvester bucket.



CATCHING TROUGH DETAIL

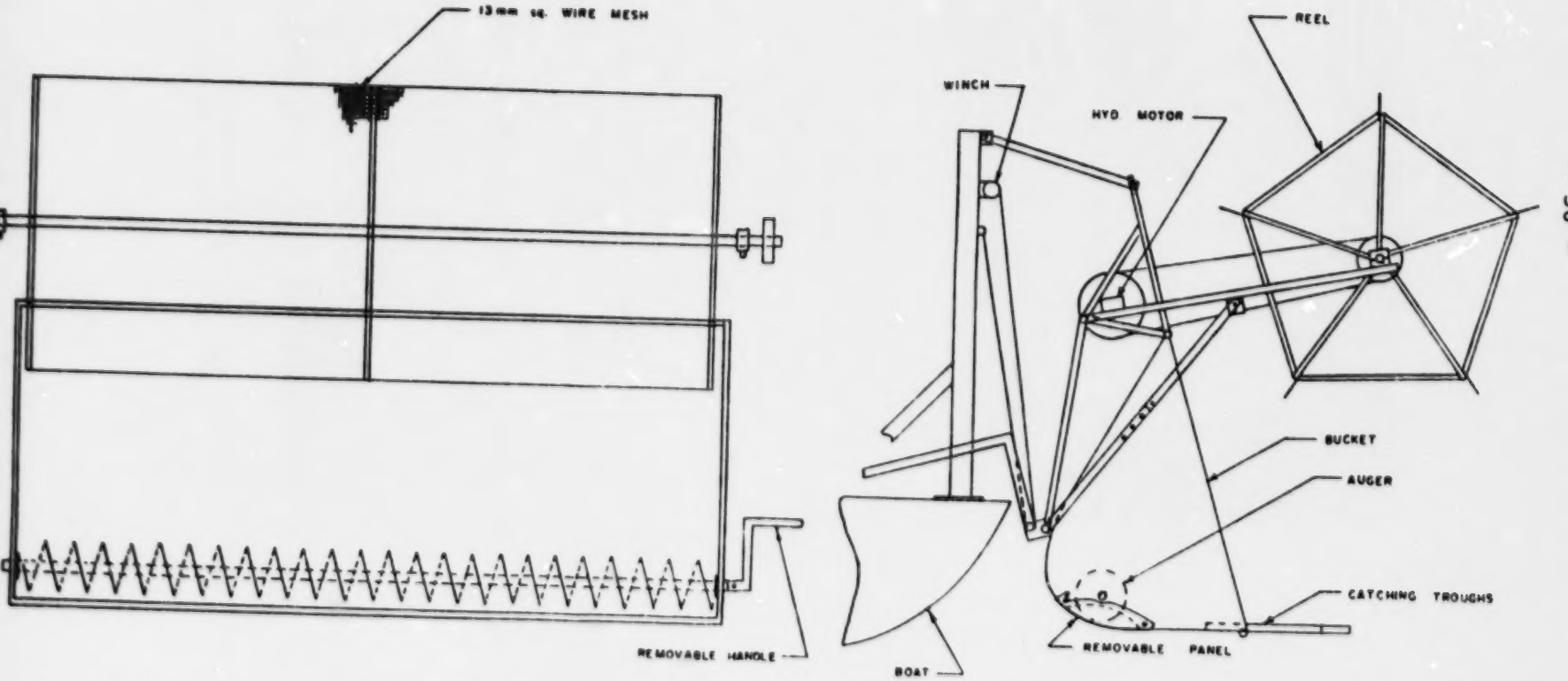


Figure 1A. Schematic diagram of reel auger and catching troughs.

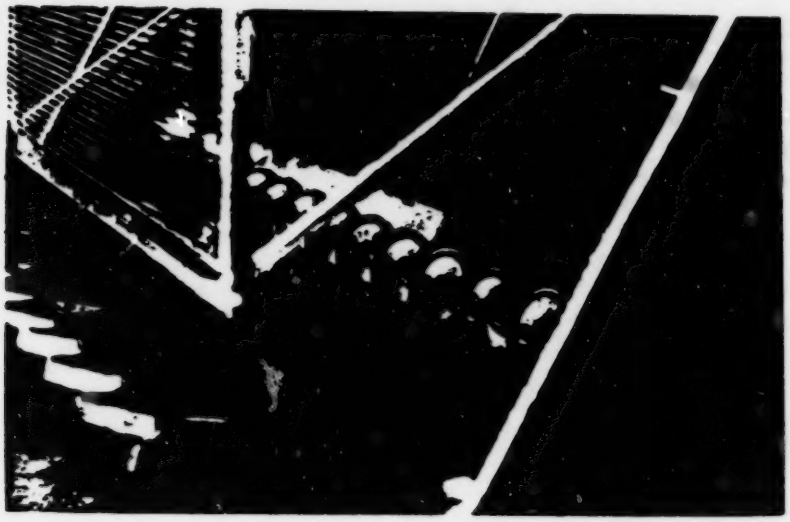


Figure 3. The Unloading auger.

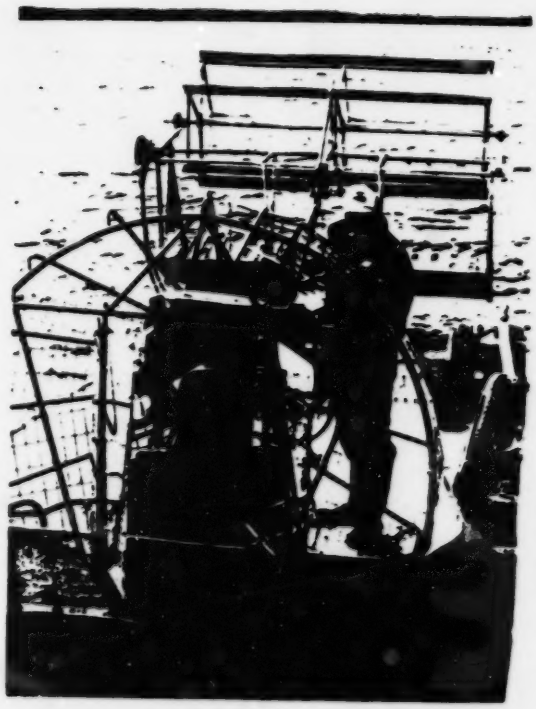


Figure 4. The complete harvester in the Bigstone lake.

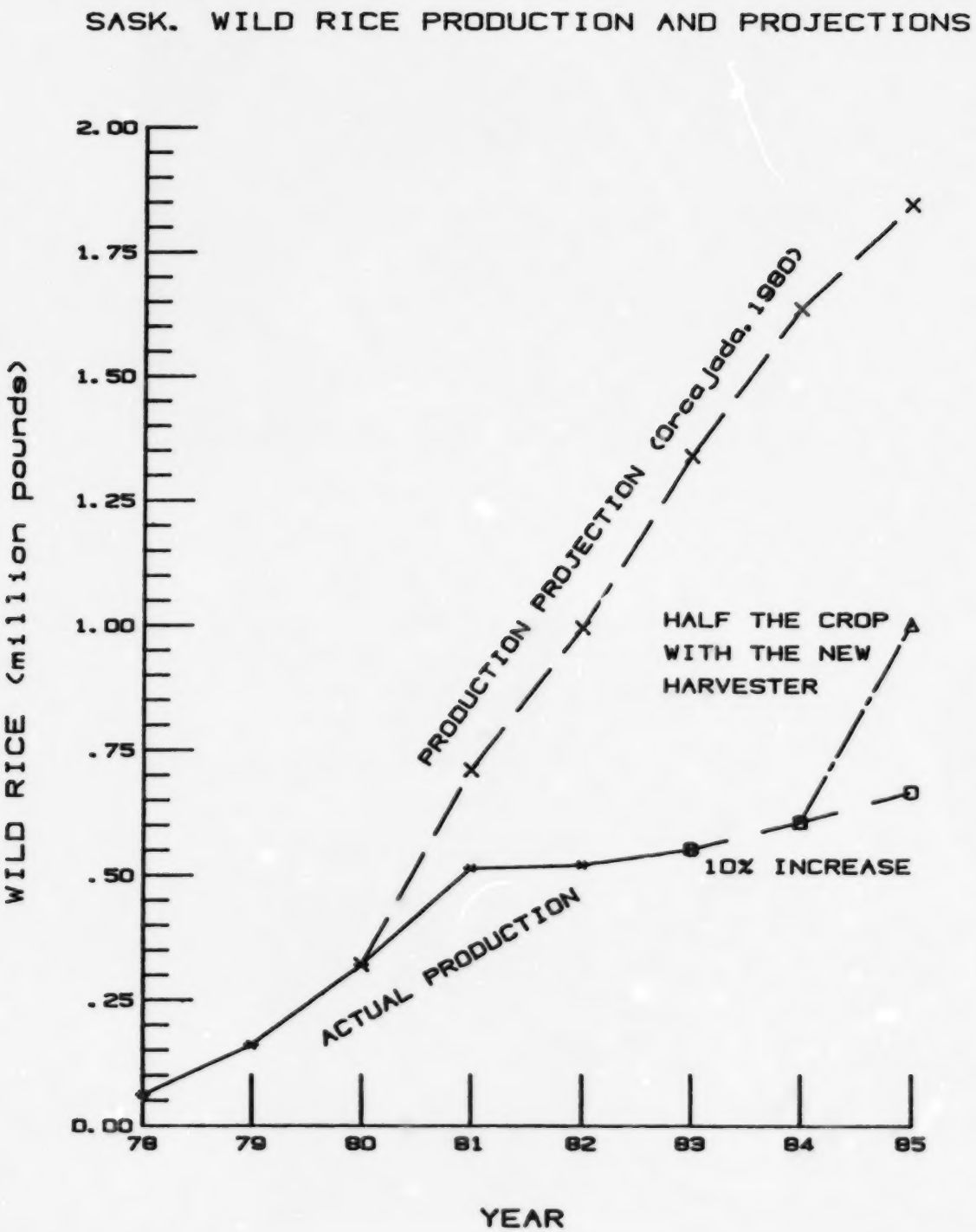

SASK. WILD RICE PRODUCTION AND PROJECTIONS
WILD RICE (million pounds)
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
0.00
78
79
80
81
82
83
84
85
YEAR
PRODUCTION PROJECTION (Oreajada, 1980)
HALF THE CROP WITH THE NEW HARVESTER
10% INCREASE
ACTUAL PRODUCTION

Figure 5.

ECONOMICS OF WILD RICE FARMING
(A Theoretical Break-even Analysis)

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To be able to analyze theoretically the economics of wild rice farming, a reference should be made on a major item of operation. This item is the mechanical harvester. It is expensive but necessary, without which it is not advisable to commercially grow wild rice. The use of the harvester will enable the grower to determine the size of his operation. It is therefore used here as a basis of the break-even analysis as shown:

ASSUMPTION:

1. Size of operation - one (1) harvester unit.

2. Area required - 110 acres (minimum).

3. Production per acre - 144 pounds (minimum).

4. Computation of harvester operation

    4.1. Operating speed - 10 m.p.h. (52,00 f.p.h.)

    4.2 Width of harvest table - 8 feet (minimum)

    4.3 Average effective harvesting time

        Per 10 hour day - 6 hours
        (4 hours downtime)

    4.4. Number of times harvest or passes is repeated per acre - 8 times (minimum)

    4.5 Average quantity of rice harvested per pass - 18 pounds

4.6 Computation of area

4.6.1. Area harvested per hour

$$= \frac{\text{speed x width of table}}{\text{area in acres}}$$

$$= \frac{52{,}600 \times 8}{43{,}500}$$

Area Harvested
Per Hour = 9.66 acres/hour

4.6.2. Area Covered
in six (6) hours = 58 acres

4.6.3. Area needed to maximize use of one (1) harvester (harvesting is repeated every other day during the duration of the harvest season) = 116 acres

---

Assume = 110 Acres

---

5. Computation for Break-even Analysis

5.1 Capital Outlay

ITEMS	COST (Estimates)	TERMS OF PAYMENT (Years)	RATE (%)	INTEREST YEARLY PAYMENT			TOTAL YEARLY AMORTIZATION (Capital)		
				1	2	3	1	2	3
5.1.1. Mechanical Harvester	9,000	3	14	1,260	840	420	4,260	3,840	3,420
5.1.2 Trailer	2,000	3	14	280	186	92	950	856	752
5.1.3. Outboard motor and boat (20 h.p. and 16 foot boat)	3,500	3	14	490	326	162	1,660	1,496	1,322
5.1.4. Seeder	400	3	14	56	36	17	196	176	156
5.1.5. Seeds (25 pounds/ acre at $1.50/ pound for 110 acres)	4,125	3	14	578	385	193	1,953	1,760	1,568
TOTAL	19,025			2,664	1,773	884	9,019	8,128	7,218

5.2. Operating Costs

ITEMS	COST (YEARLY)
A. Care of Crops	
1) Labour for seeding, clearing, inspection, etc. at $7.00 per hour for 75 hours	525.00
2) Fuel, oil, maintenance of outboard motor, etc. (75 hours at $2.00/per hour)	150.00
B. Harvesting Operation	
1) Bags (300 at $0.70/each)	210.00
2) Fuel, oil, etc. (160 hours of operation)	400.00
3) Labor ($10.00/hour for operator and $6.00/hour for helper for 160 hours)	2,560.00
4) Handling, transport, etc. (at $0.03/lb. for 15,840 lbs.)	475.00
5) Maintenance, repairs, parts, etc. (for harvester and outboard motor)	1,000.00
C. Miscellaneous (10% of cost of operation which is $5,320.00)	532.00
D. Interest expense on total operating costs which is $5,852.00 at 14% for six months	410.00
	$6,262.00

5.3. Depreciation (straight line)

ITEMS	LIFE (YEARS)	AMOUNT DEPRE-CIATED (YEARLY)
A. Harvester ($9,000.00)	5	$1,800.00
B. Trailer ($2,000.00)	5	400.00
C. Outboard motor and boat ($3,500.00)	5	700.00
D. Seeder ($400.00)	5	80.00
	TOTAL	$2,980.00

5.4 Royalty costs (payment to government of $0.05/per pound for 15,840 pounds) = $792.00.

5.5. Summary of Yearly Costs

TYPE OF OPERATION	COSTS (YEARLY)				
	1	2	3	4	5
5.5.1. Amortization on Loan plus interest charges	9,019	8,128	7,218	ø	ø
5.5.2. Cost of operation	6,262	6,262	6,262	6,262	6,262
5.5.3 Depreciation	2,980	2,980	2,980	2,980	2,980
5.5.4. Royalty payment to government	792	792	792	792	792
T O T A L	19,053	18,162	17,252	10,034	10,034

5.6. Break-even = $\frac{\text{Total yearly cost}}{\text{Total yearly production}}$

First year = $\frac{19053}{15840}$ = \$1.20/pound

Second year = $\frac{18162}{15840}$ = \$1.15/pound

Third year = $\frac{17252}{15840}$ = \$1.09/pound

Fourth year = $\frac{10034}{15840}$ = \$0.63/pound

6. Projected Net Income (before taxes)

6.1 At 144 pounds per acre for 110 acres (15,840 pounds)

6.2 At \$1.50 per pound (green rice)

YEAR	NET INCOME PER POUND (\$)	NET INCOME PER YEAR (ONE HARVESTER UNIT OPERATION)
1	0.30	\$ 4,752.00
2	0.35	5,544.00
3	0.41	6,494.00
4	0.87	13,780.00
5	0.87	13,780.00

Saskatchewan Agriculture

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